Validating Demand Control Ventilation in Laboratory Environments

Promise vs. Practice

David Brummitt, CIH, CSP

3Flow™

Don’t let airflow become an invisible threat

Learning Objectives

1. Recognize the factors affecting the risk of exposure to airborne hazards in labs and critical workspaces.
2. Understand how Demand Control Ventilation (DCV) systems operate and what defines proper performance.
3. Learn how a risk assessment helps establish appropriate specifications for DCV systems.
4. Understand how air tracer tests are necessary to challenge and validate DCV performance.
5. Recognize the importance of managing and maintaining performance of DCV systems.

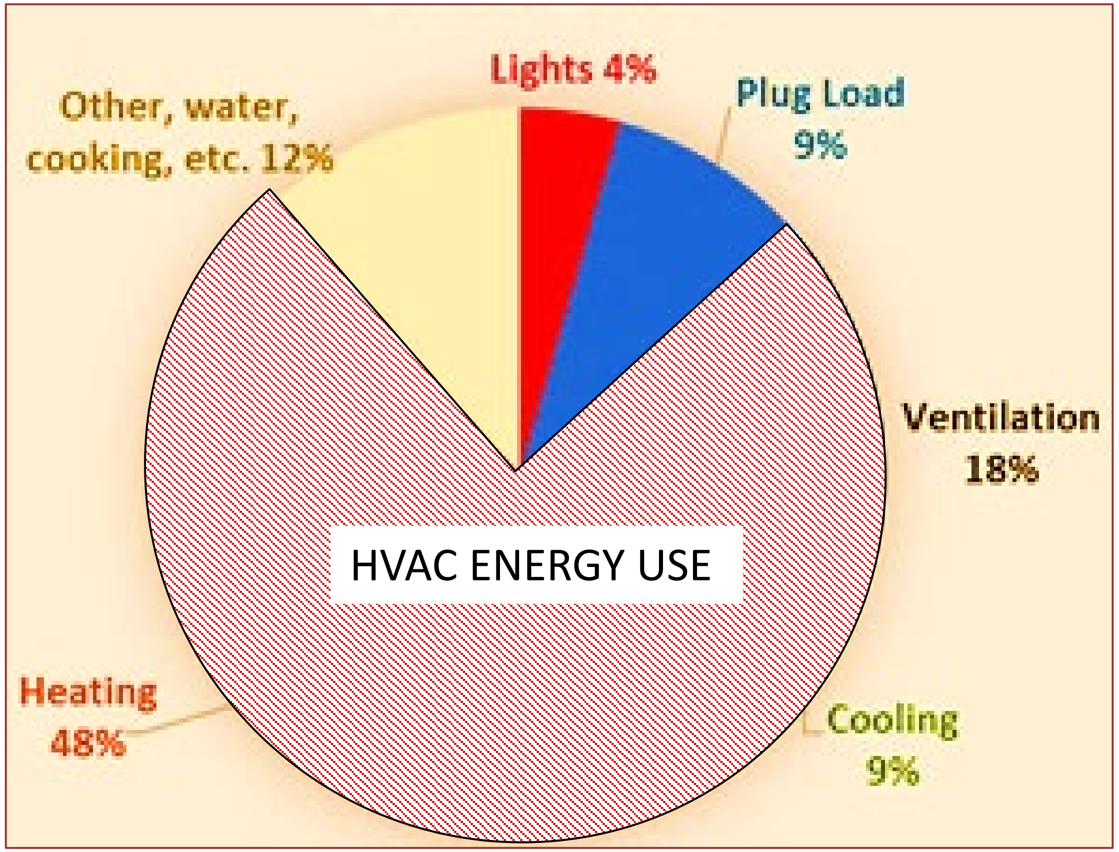
Our Role
Safety | Efficiency | Sustainability

Enhance safety & environmental health

Optimize efficiency & reduce waste

Mitigate risk to sustain operational success

Why This Topic Matters



As much as 50% of HVAC energy may be wasted by improper airflow and inefficient systems

Understanding DCV

The oversimplified version

Sensors

BAS Controls

Valves

ECDs

Dampers

Modulation

AHU

Risk

CO_2

VOC

PM

Occupancy

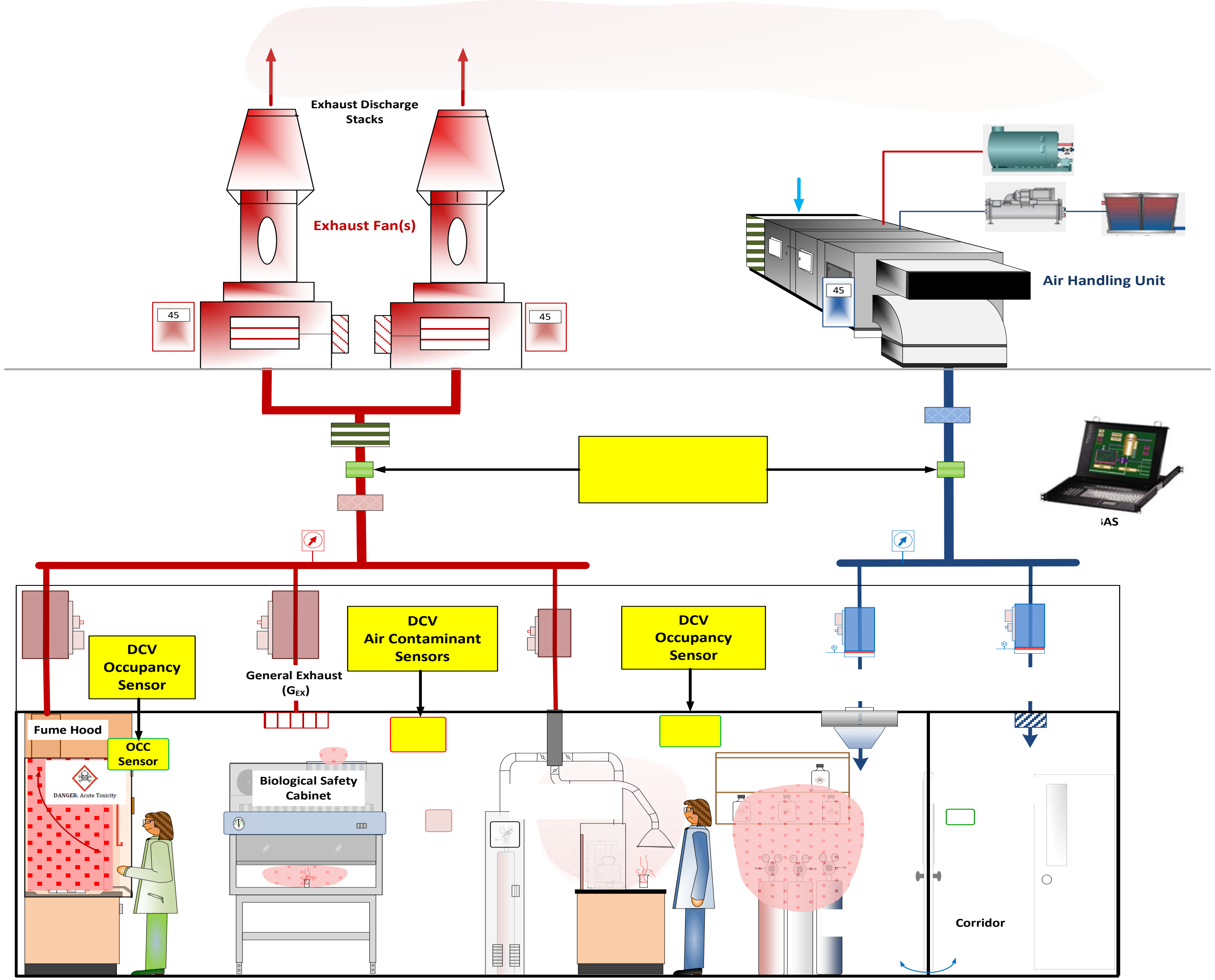
Temperature

DCV Basics

Types of DCV Sensors

- Lab Occupancy
- Fume Hood Occupancy
- Air Quality Sensors
  - O_2
  - CO_2
  - TVOCs
  - Particulate
  - Toxic Gases
  - Others

The Air Supply Flow Tracks The Exhaust Flow for Proper Air Balance

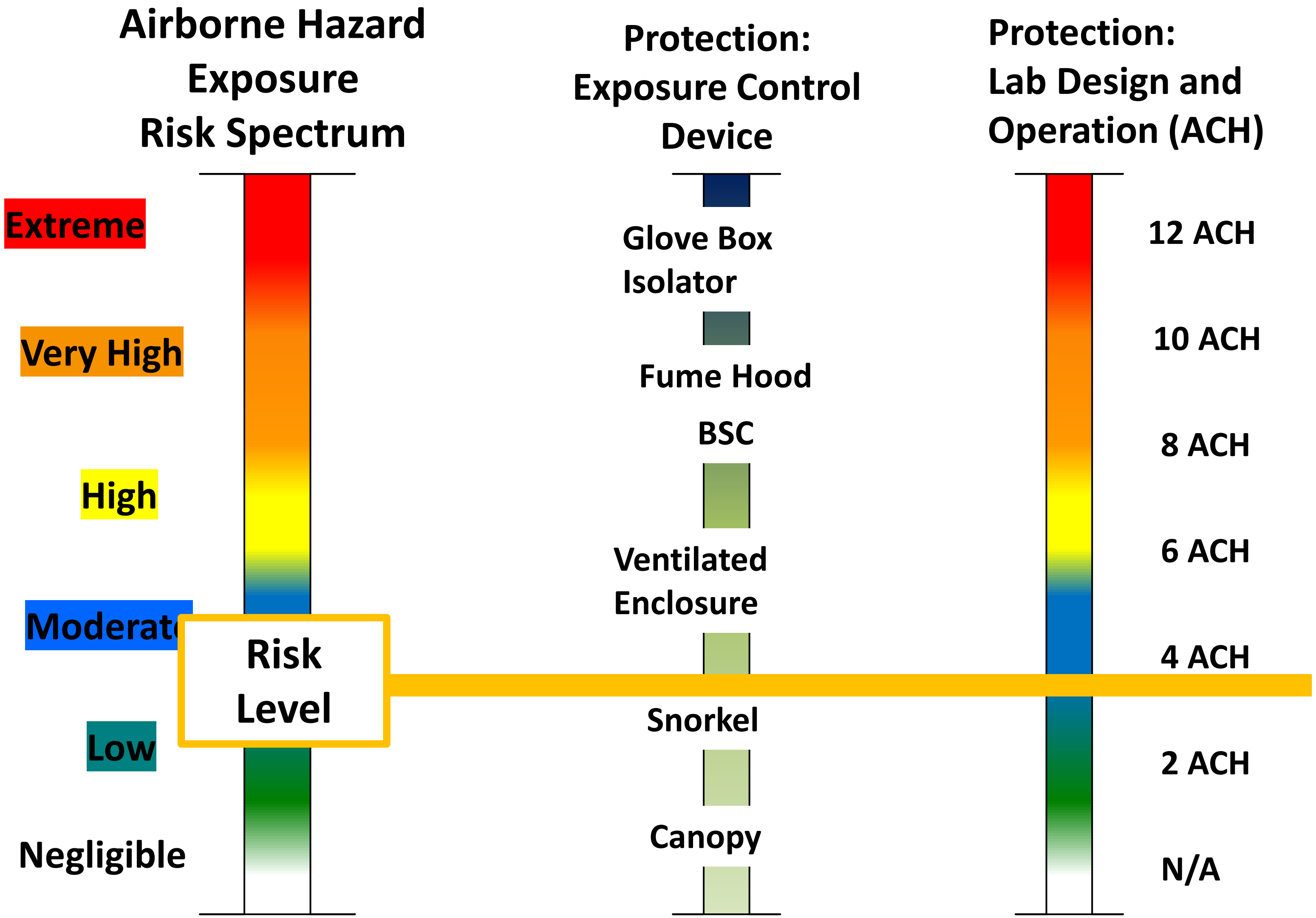


Labs are Different

Where DCV Fits in the Risk Assessment Framework

Parameter	RCB-0	RCB-1	RCB-2	RCB-3	RCB-4
Min. Effective ACH – Occupied	n/a	4	6	8	**Criteria and Operating Specifications based on special needs of application.**
Min. Effective ACH – Unoccupied		2	3	4	
Recirculation of Lab Air	Yes	Filtered	Internal	Internal	
Lab Pressurization (IWG) (4)	Neutral	Neutral – (-) 0.005	(-) 0.005 – (-) 0.010	(-) 0.010 – (-) 0.050	
Lab Offset Volume – cfm or cfm per ft² of floor space (4)	N/A	100 cfm $\geq$ 0.25 cfm/ft²	200 cfm $\geq$ 0.35 cfm/ft²	300 cfm $\geq$ 0.75 cfm/ft²	
Room dP Monitor	n/a	n/a	Review	Yes	
Airlock/Vestibule	n/a	n/a	n/a	n/a	
Flow Setback (Demand Control Ventilation)	Yes	Yes	Yes	Review	
Emergency Purge Mode	No	No	No	Review	
Ventilation Effectiveness Factor (5)	<= 1	<= 1	<= 1	< 1	

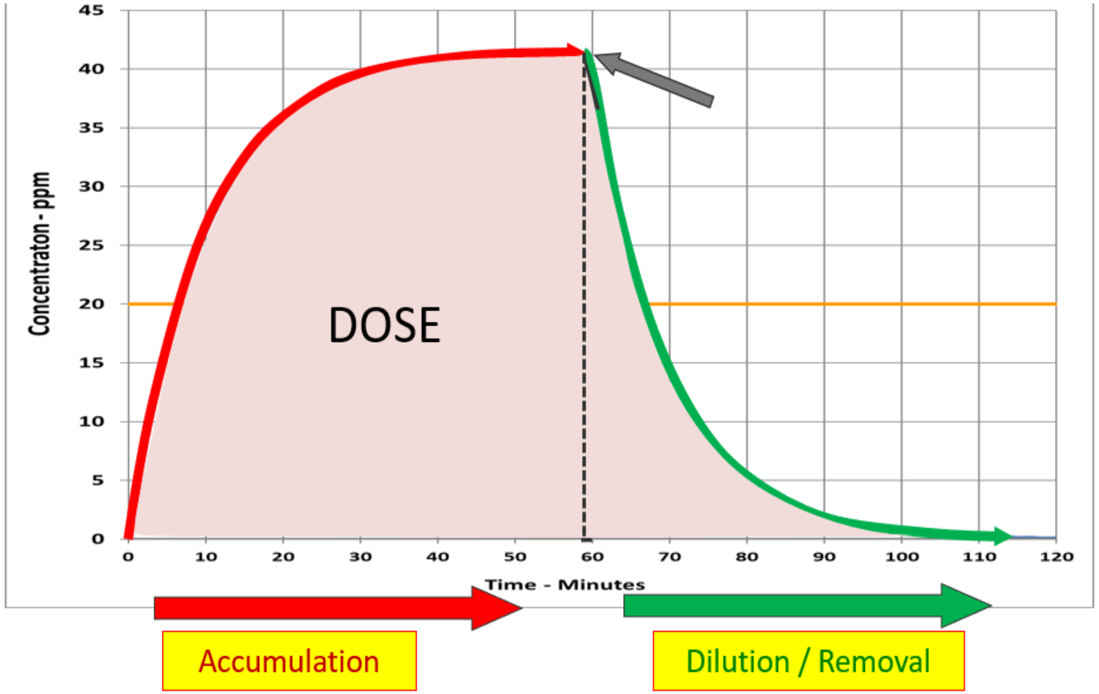
Where DCV Fits in the Risk Assessment Framework



The Purpose of Ventilation

Source Capture

Dilution



Isolation

DCV is applied to detect airborne hazards and increase ventilation to more rapidly dilute contaminants

Why Airflow Patterns Matter

Case 1
- 4 Way Vane Diffuser
- Rotating Mixing Fan

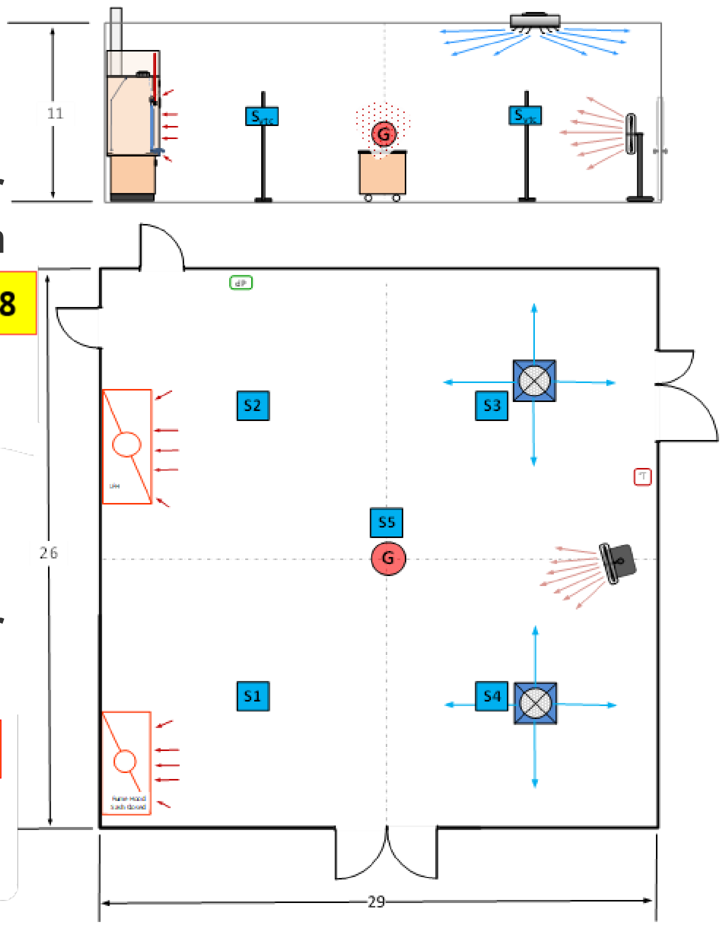
VEFF Test Rating = 1.2, Ez = 0.8

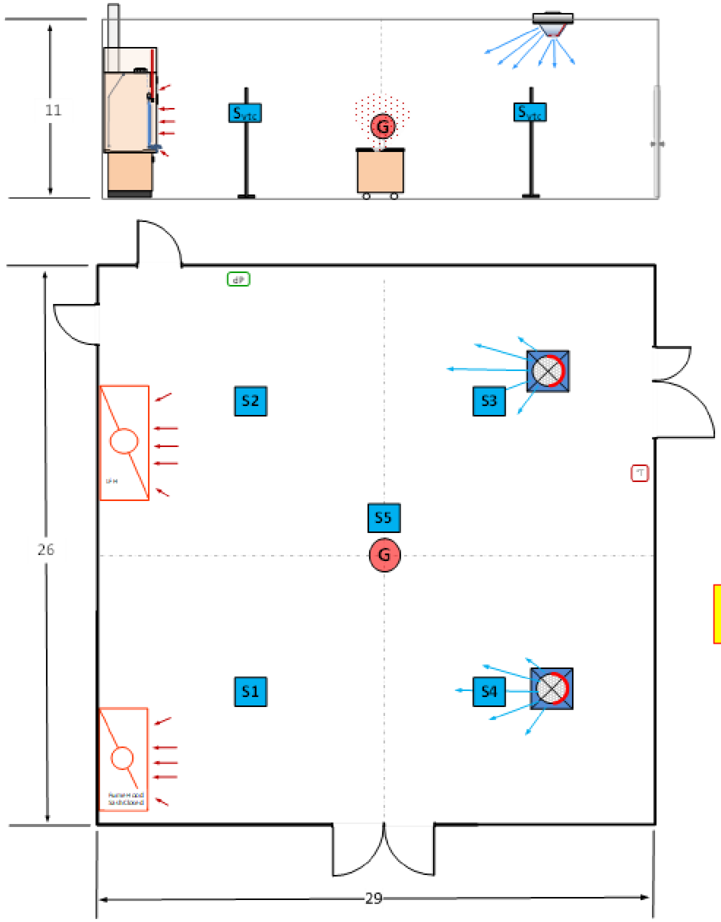
Effective Air Change Rate: 3.4 ACH

Case 2
- 4 Way Vane Diffuser
- No Mixing Fan

VEFF Rating = 2.7, Ez = 0.37

Effective Air Change Rate: 1.5 ACH





Case 3
- Directional Displacement Diffuser
- No Mixing Fan

VEFF Rating = 0.56, Ez =1.78

Effective Air Change Rate: 7 ACH

When 4 ACH ≠ 4 ACH

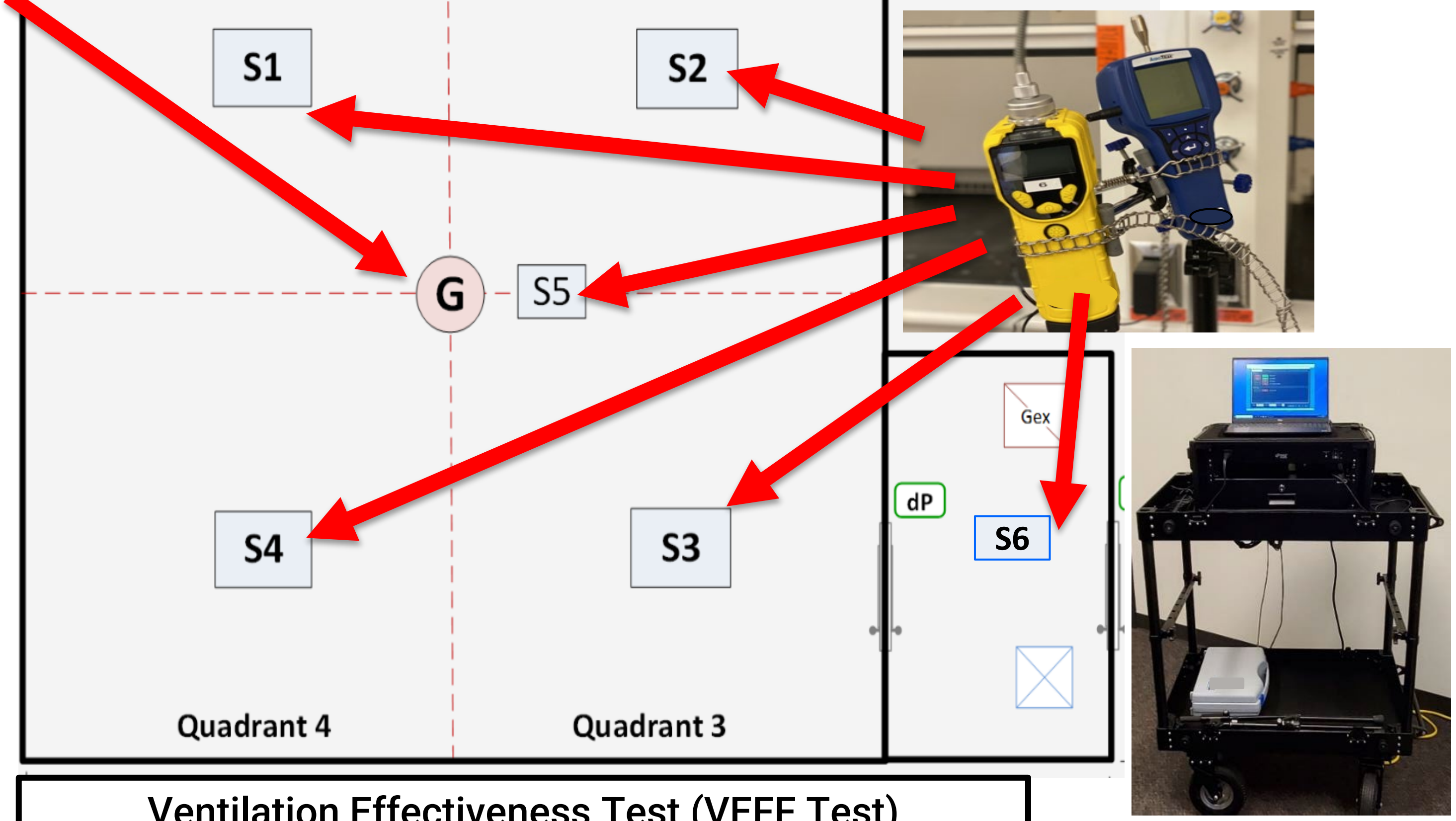
Measuring Ventilation Effectiveness

Generate Hybrid Air Tracer (Gas and/or Particles)

- Divide Space into 4 Quadrants
- Generate Air Tracer at Center of Quadrants (G)
  - Duration: 5 - 10 minute
  - Rate: 1 – 2 lpm
- Detectors Placed at Sample Locations (S1-S6)
- Test Cycle Duration ≤ 60 minutes
- Calculate Dose for each Quadrant and Determine Average Dose (S1-S5)
- Compare Average Dose to Theoretical Dose

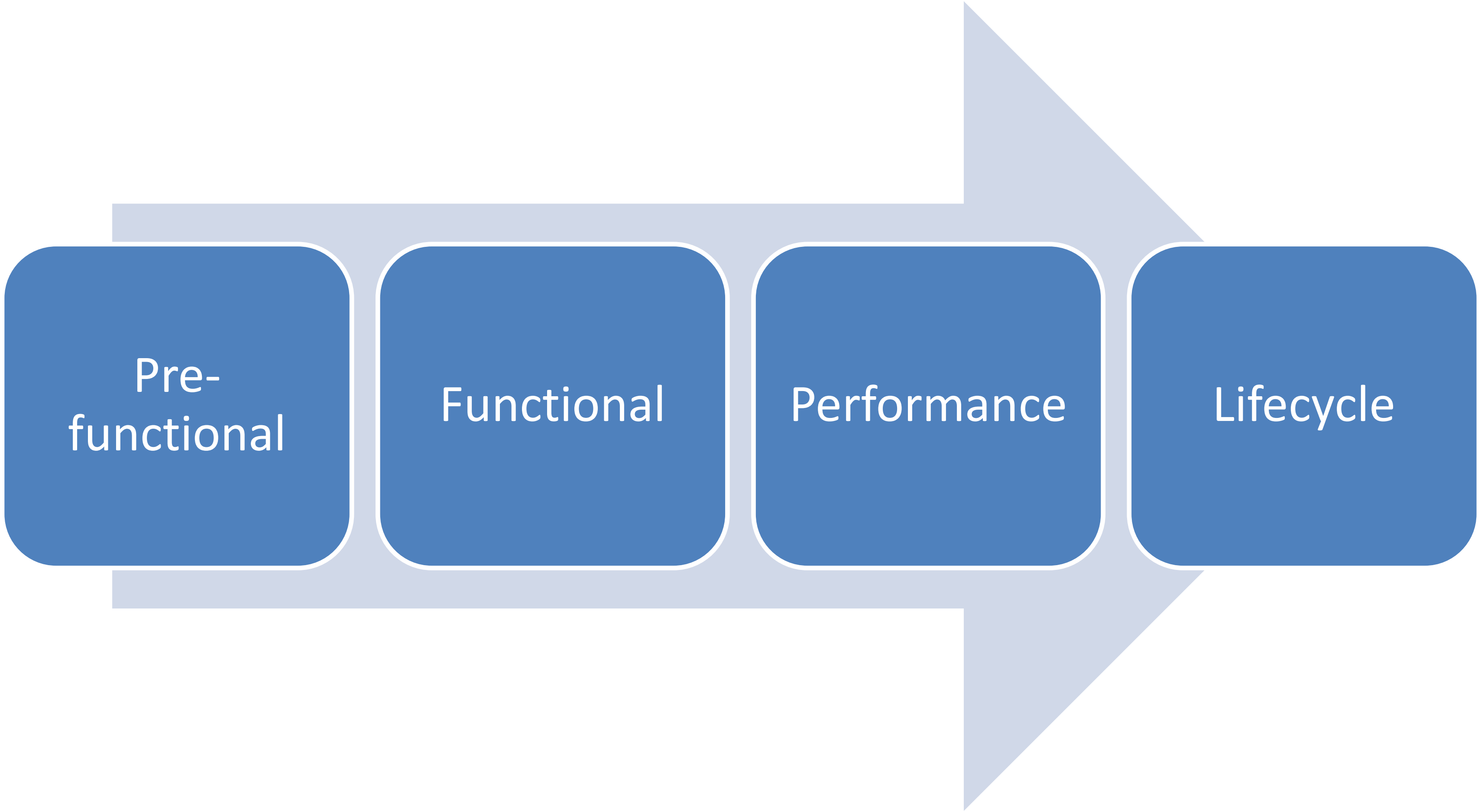
VEFF Rating = Average / Calculated
$E_z = C_{ex} / C_{bz}$

Measure Gas and/or Particle Concentrations

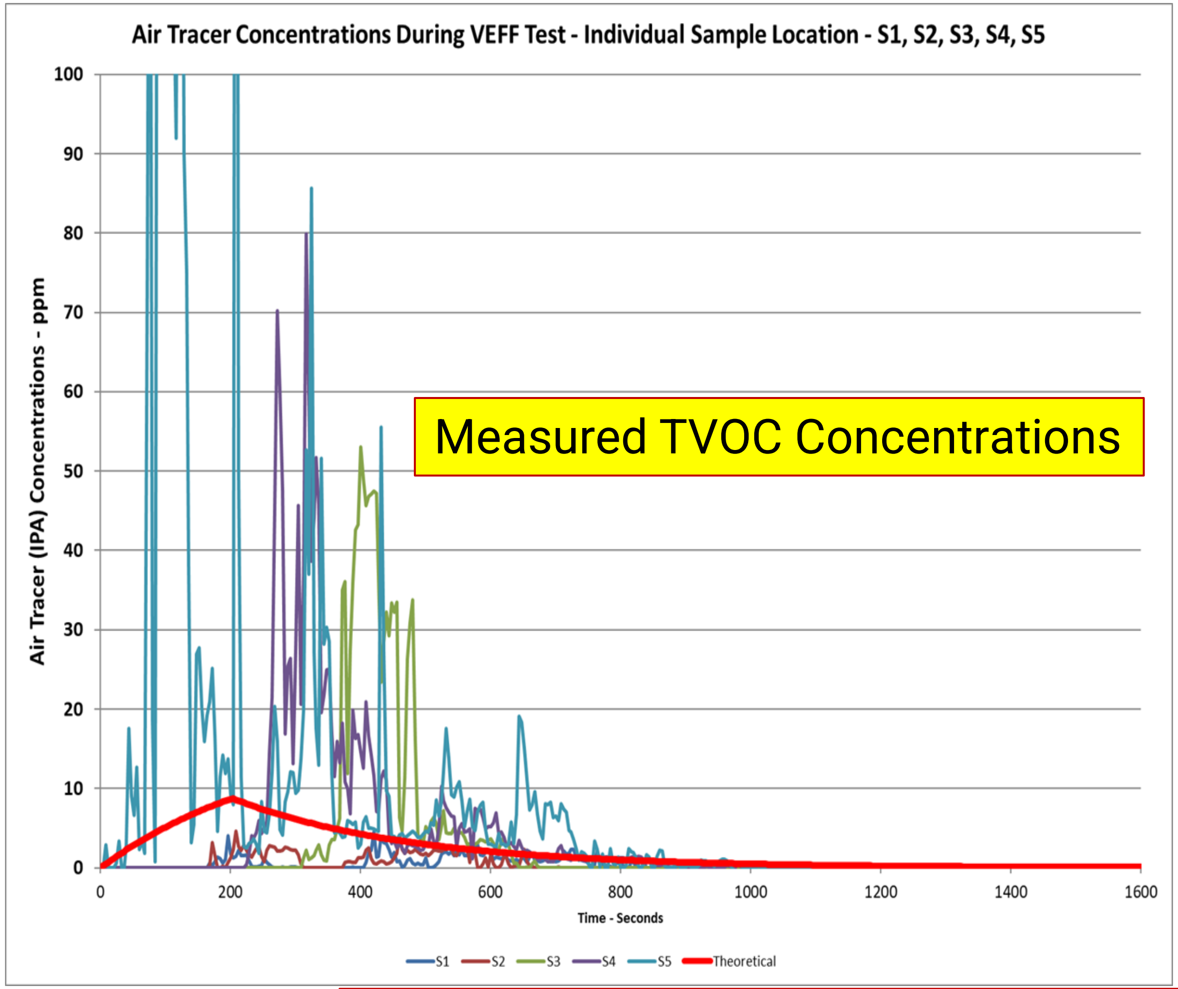


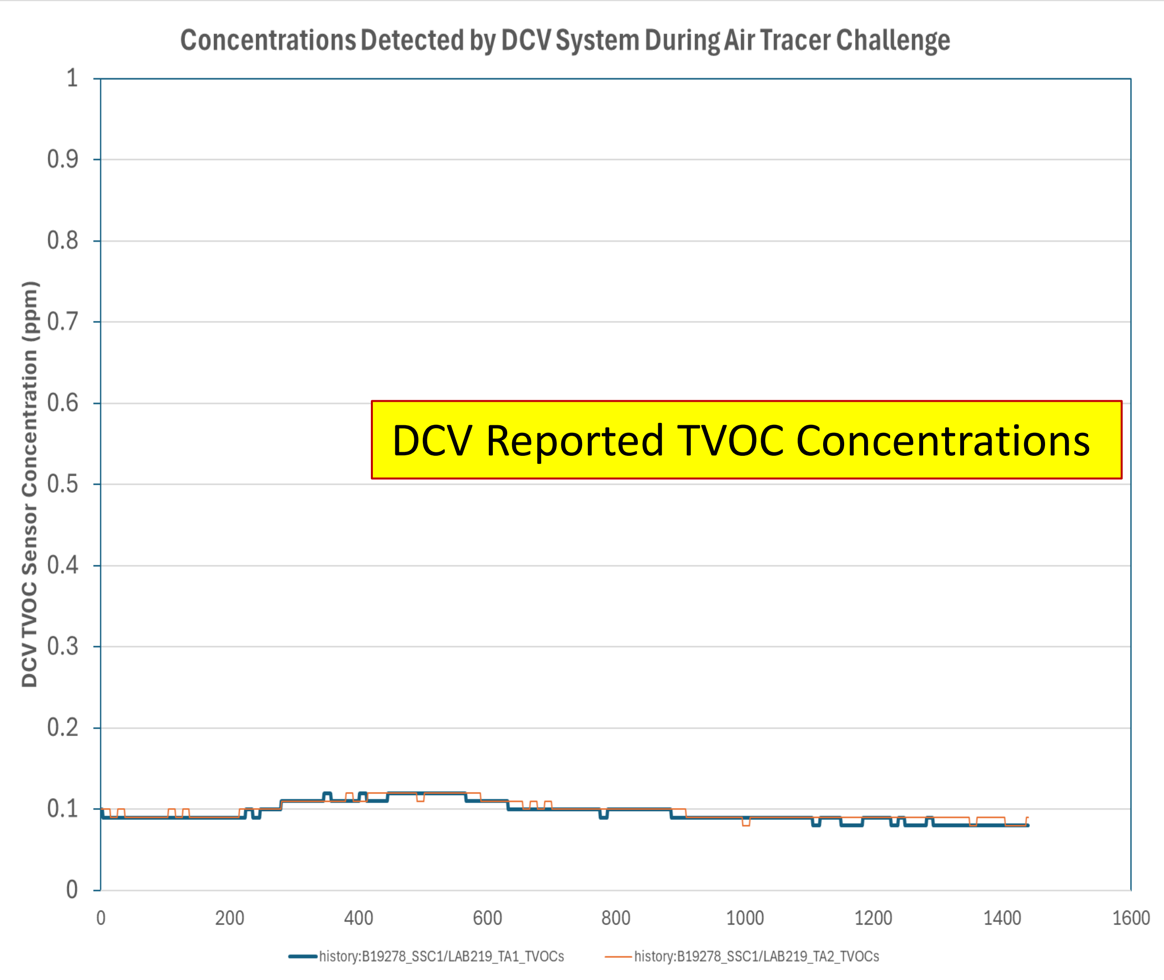
Ventilation Effectiveness Test (VEFF Test)

Validation Process



Case Study: What We Found





Actual Concentrations were 100 times the DCV reported Concentrations

Validation Checklist

- Sensor calibration
- Location & airflow path
- Response time
- Integration with VAV controls
- Data trending & alarm logic

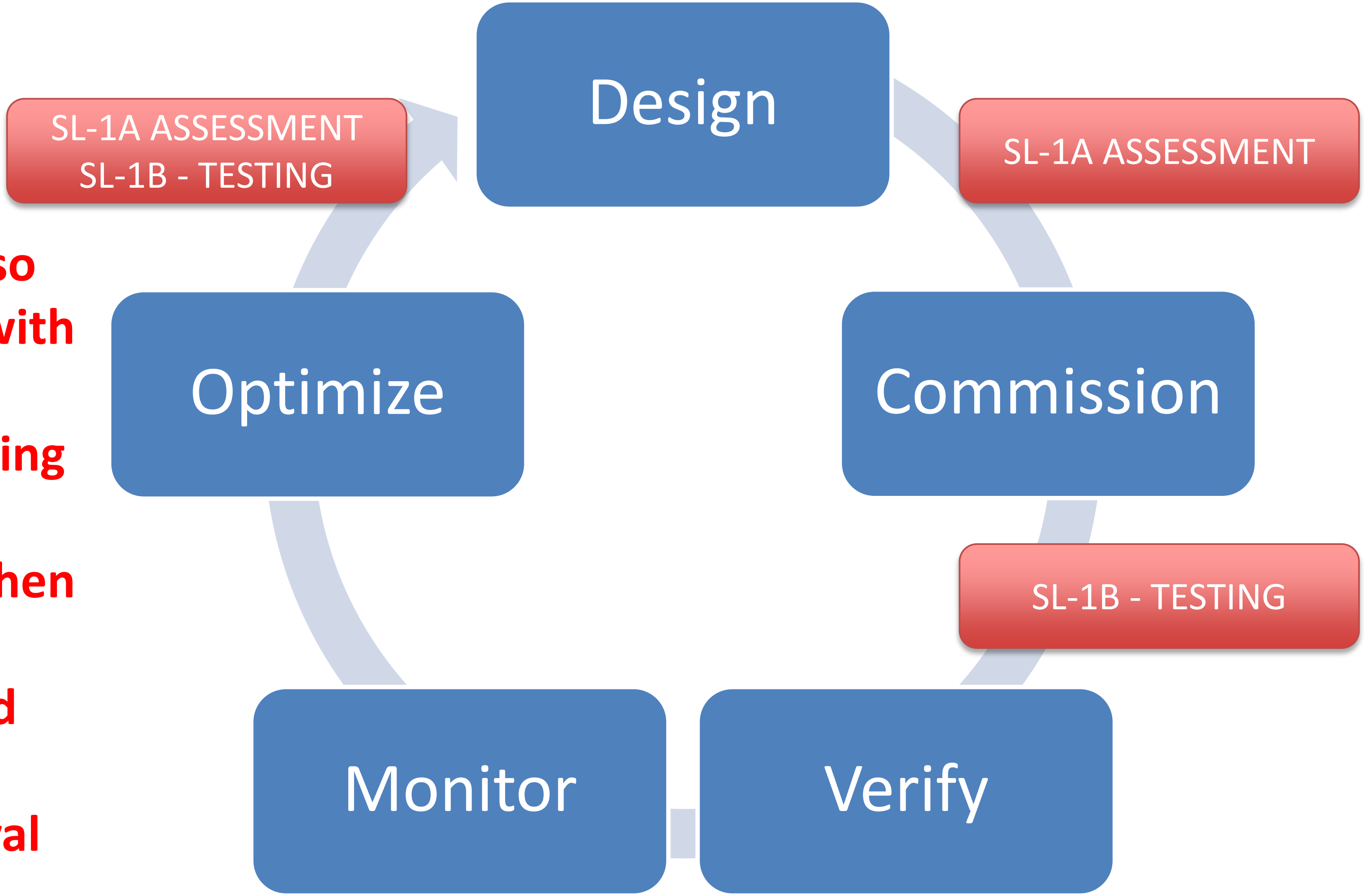
Top 5 DCV Pitfalls

- Sensor Drift
- Dead Zones
- Slow Sampling
- Controls Conflicts
- Complacency

Keys to Reliable Performance

Not luck, but a cycle

Validation Cycle – "Close the Loop"



Tests should also be conducted with and without systems operating (to provide a baseline) and then validate flow modulation and enhanced dilution/removal

Questions?

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